

# Microprocessor Relay Integration

## With NovaTech Orion Substation Automation Platforms



Orion5r



Orion5



Orion16

In addition to providing critical protection of substation apparatus and lines, microprocessor-based relays can provide nearly all of the real-time operational data and fault analysis data required by utility engineers and operators. Examples of available data and status include: metering, breaker status, breaker health, transformer temperature, event records, fault records and oscillography.

Integrating these protective relays and available data into a functional system requires a combination of the right physical ports, protocols, storage and logic. In addition, the “Substation Automation Platform” that performs these tasks needs to be rugged, reliable and easy to use.

NovaTech has designed the Orion family of Substation Automation Platforms to provide a complete range of integration solutions for microprocessor relays, from accessing engineering data to complete substation automation.

This Application Note describes the most common applications of the Orion Substation Automation Platform in Microprocessor Relay Integration. Additional application notes will be added to future revisions of this document.

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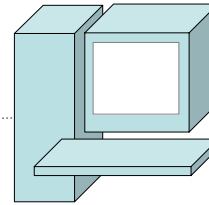
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## Application #1a:

# Accessing Relay Engineering Data Locally and Remotely from SEL Relays

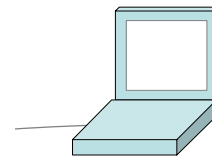


Remote engineering workstation running SEL5010 configuration software or in an ASCII terminal emulation session

Four SEL relay access methods are supported by Orion:

- 1) Remote engineering workstation using dial-up phone connections
- 2) Remote engineering workstation over Ethernet using a Telnet session
- 3) Local connection over Ethernet using a Telnet session
- 4) Local connection using point-to-point ASCII

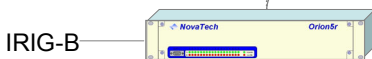
Orion operates in true “pass through” mode. Users can select the port on Orion that is connected to the desired SEL relay and use SEL software as if directly connected point-to-point to the relay



Local Computer

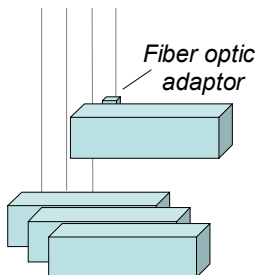
Local connection up to the maximum baud rate supported by the relay

All Orions can be equipped with a built-in dial-in/dial-out modem or with Ethernet



IRIG-B

Orion can link to SEL relays using RS232 or using fiber optic



Up to 17 SEL relays can be connected per Orion5r. Please see page #14 describing techniques for connecting more than 17 relays to multiple Orions.

In port switch applications, Orion uses SEL ASCII or SEL Fast Meter to communicate to SEL relays. Orion can multiplex multiple communications to SEL relays (e.g. operate breakers, obtain metering, and upload records).

Orion can also distribute synchronized IRIG-B to connected SEL Relays.

SEL event reports and SER time stamps can be accessed and stored in the large 24MB Orion memory for flexible and fast retrieval or for use in automation applications. See next page for additional detail of how Orion handles events reports and SER from SEL relays.

**In applications where both remote relay access and automation are required**, two connections may be made to the SEL relay to improve automation performance. The first connection may be SEL ASCII or Fast Meter for engineering access and the second may be DNP3.0, Modbus or Ethernet (depending on model) for automation.

Orion is also designed to operate as a full-function RTU. See the RTU application page for details.

*Application #1a (continued):*

## Accessing Relay Engineering Data Locally and Remotely from SEL Relays

All event data and SER data captured by the SEL relay can be accessed directly from the SEL relay using the Orion “pass through” mode. In this mode Orion acts as a transparent port switch. When a local or remote PC is attached to the SEL relay through Orion, a terminal emulation session or SEL software programs can be launched to access event data and SER data.

For applications where the user desires access to event data and SER data using other access methods and protocols, the following techniques can be used:

### **Accessing SEL Standard Event Report Summaries**

Orion will capture the Standard Event Report Summaries that are automatically sent from the SEL relay and place into a non-volatile buffer in Orion memory. Each piece of data in the latest record will be available to be read by any Master device attached to Orion using any Master protocol (e.g. DNP3.0). The Master device will advance to the next record in the buffer by pulsing an virtual output on Orion. Available event data includes:

Event Month	Event Day
Event Year	Event Hour
Event Minute	Event Second
Event Millisecond	Event Code
Event Location	Event Shot
Event Frequency	Event Targets
Event IA	Event IN
Event IB	Event IG
Event IC	Event IQ

### **Accessing SEL Standard Event Report History**

Orion will capture and store the most recent 12 Event Report records sent from the SEL relay and store in non-volatile memory as History records. All data in the 12 History records (and each individual piece of data if desired) will be available to be read by any Master device attached to Orion. History can be cleared by pulsing a virtual output on Orion.

### **Handling SEL SER time stamps**

Orion can capture time stamps applied to changes in input or output states, relay pick-ups and other relay events. Orion can also present the status and time to any Master device attached. The user should make certain the points to get an SER time stamp are selected and configured in the SEL relay (an SER time stamp is applied to some points as a default, but not all points). Orion will capture these events and SER time stamps when they are automatically sent by the relay.

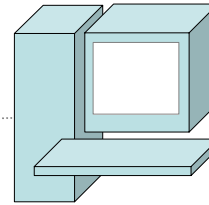
### **Handling SEL Full-Length Standard Event Reports**

Orion can capture and store full-length standard event reports and make them available to users. Orion retrieves the ASCII text file from the SEL relay and stores it in non-volatile memory. Techniques for users to access these files include:

- 1) Users can retrieve files from Orion using .ftp after dialing in to Orion or accessing Orion via Ethernet.
- 2) Orion can dial out to a PC, make the connection and send the file(s) out.
- 3) Orion can serve out a web page over a dial-in or dial-out phone line or over Ethernet. The SEL full-length event reports can be attached to this web page.

## Application #1b:

# Accessing Relay Engineering Data Locally and Remotely from ABB REL512 Relays

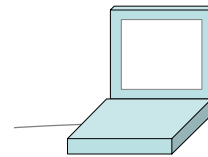


Remote engineering workstation running RELTools software or in an ASCII terminal emulation session

Four ABB REL512 relay access methods are supported by Orion:

- 1) Remote engineering workstation using dial-up phone connections
- 2) Remote engineering workstation over Ethernet using a Telnet session
- 3) Local connection over Ethernet using a Telnet session
- 4) Local connection using point-to-point ASCII

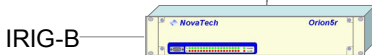
Orion operates in true “pass through” mode. Users can select the port on Orion that is connected to the desired REL512 relay and operate as if directly connected point-to-point to the relay



Local Computer

Local connection up to the maximum baud rate supported by the relay

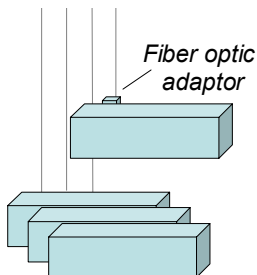
All Orions can be equipped with a built-in dial-in/dial-out modem or with Ethernet



Up to 17 REL512 relays can be connected per Orion. Please see page #14 describing techniques for connecting more than 17 relays to multiple Orions.

In port switch applications, Orion uses ASCII to communicate to REL512 relays.

Orion can link to REL512 relays using RS232 or using fiber optic



Relay records can be stored in the large 24MB Orion memory for faster retrieval.

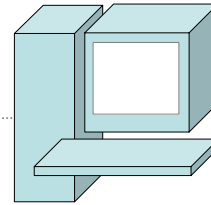
**In applications where both remote relay access and automation are required**, two connections are usually made to the ABB REL512 relay; one ASCII connection for engineering access and a second connection for automation (DNP3.0 or Modbus Plus depending on model).

Orion is also designed to operate as a full-function RTU. See the RTU application page for details.

## Application #1c:

# Accessing Relay Engineering Data

## Locally and Remotely from ABB DPU/TPU2000/2000R Relays

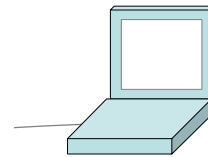


Remote engineering workstation running ABB WinECP software

Two ABB DPU/TPU2000/2000R relay access methods are supported by Orion:

- 1) Remote engineering workstation using dial-up phone connections
- 2) Local connection using serial 10-byte

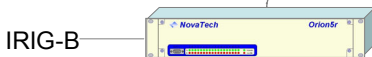
Orion operates in true “pass through” mode. Users can select the port on Orion that is connected to the desired ABB DPU/TPU2000/2000R relay and operate WinECP software as if directly connected point-to-point to the relay



Local Computer

Local connection up to the maximum baud rate supported by the relay

All Orions can be equipped with a built-in dial-in/dial-out modem or with Ethernet

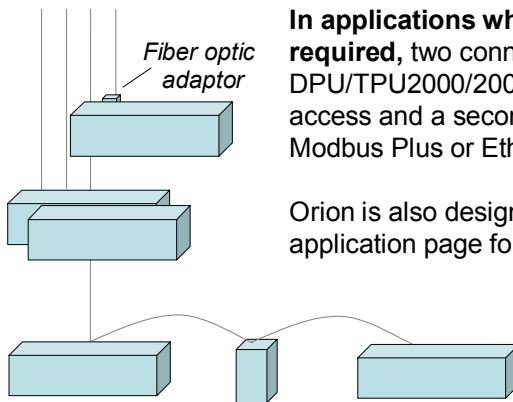


Up to 17 ABB DPU/TPU2000/2000R relays can be connected in point-to-point connections per Orion. Up to 32 DPU/TPU relays can be connected *per Orion port* when using the RS485 option on Orion and on the relays. Please see page #14 describing techniques for connecting more than 17 relays to multiple Orions.

Orion can link to ABB DPU/TPU2000/2000R relays using RS232, RS485 or using fiber optic

In port switch applications, Orion passes through the ABB 10-byte protocol used to communicate to the relays. If the DPU2000R is equipped with Ethernet, oscillographic records can be obtained at higher speed over that medium.

**In applications where both remote relay access and automation are required, two connections are usually made to the ABB DPU/TPU2000/2000R relay; one 10-byte connection for engineering access and a second connection for automation (DNP3.0, Modbus, Modbus Plus or Ethernet, depending on model).**

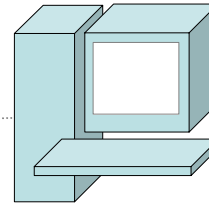


RS485 Multi-drop

## Application #1d:

# Accessing Relay Engineering Data

## Locally and Remotely from Basler BE1-CDS240 or BE1-1051 Relays

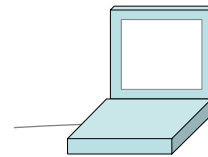


Remote engineering workstation running Basler BESTCOMS GUI software or in an ASCII terminal emulation session

Four access methods for the Basler BE1-CDS240 and BE1-1051 relays are supported by Orion:

- 1) Remote engineering workstation using dial-up phone connections
- 2) Remote engineering workstation over Ethernet using a Telnet session
- 3) Local connection over Ethernet using a Telnet session
- 4) Local connection using point-to-point ASCII

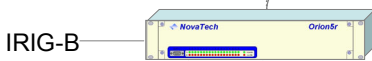
Orion operates in true “pass through” mode. Users can select the port on Orion that is connected to the desired BE1-CDS240 or BE1-1051 relay and operate as if directly connected point-to-point to the relay



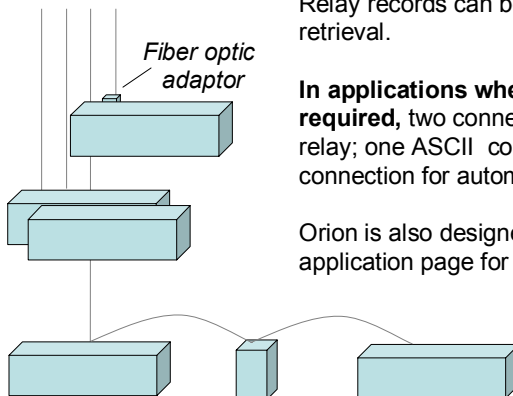
Local Computer

Local connection up to the maximum baud rate supported by the relay

All Orions can be equipped with a built-in dial-in/dial-out modem or with Ethernet



Orion can link to BE1-CDS240 or BE1-1051 relays using RS232, RS485 or using fiber optic



Up to 17 BE1-CDS240 or BE1-1051 relays can be connected per Orion in point-to-point connections. Up to 32 of these Basler relays can be connected *per Orion port* when using the RS485 option on Orion and on the relays. Please see page #14 describing techniques for connecting more than 17 relays to multiple Orions.

In port switch applications, Orion uses ASCII to communicate to the BE1-CDS240 or BE1-1051 relays. This provides complete engineering access to all configuration and records files. If the BE1-CDS240 or BE1-1051 is equipped with Ethernet, oscillographic records can be obtained at higher speed over that medium.

Relay records can be stored in the large 24MB Orion memory for faster retrieval.

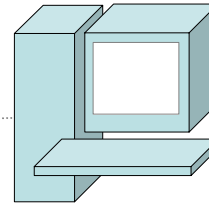
**In applications where both remote relay access and automation are required**, two connections are usually made to the BE1-CDS240 or BE1-1051 relay; one ASCII connection for complete engineering access and a second connection for automation (DNP3.0, Modbus or Ethernet depending on model).

Orion is also designed to operate as a full-function RTU. See the RTU application page for details.

## Application #1e:

# Accessing Relay Engineering Data

## Locally and Remotely from Alstom (Areva) Optimho Relays

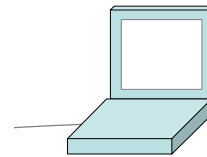


Remote engineering workstation running in an ASCII terminal emulation session

Four Optimho relay access methods are supported by Orion:

- 1) Remote engineering workstation using dial-up phone connections
- 2) Remote engineering workstation over Ethernet using a Telnet session
- 3) Local connection over Ethernet using a Telnet session
- 4) Local connection using point-to-point ASCII

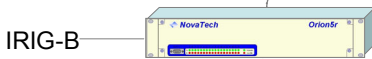
Orion operates in true “pass through” mode. Users can select the port on Orion that is connected to the desired Optimho relay and operate as if directly connected point-to-point to the relay



Local Computer

Local connection up to the maximum baud rate supported by the relay

All Orions can be equipped with a built-in dial-in/dial-out modem or with Ethernet

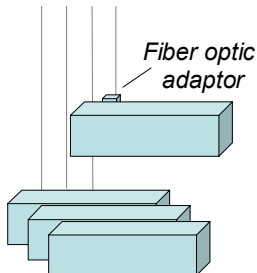


Up to 17 Optimho relays can be connected per Orion. Please see page #14 describing techniques for connecting more than 17 relays to multiple Orions.

In port switch applications, Orion uses ASCII to communicate to Optimho relays.

Orion can link to Optimho relays using RS232 or using fiber optic

Relay records can be retrieved and stored in the large 24MB Orion memory for faster retrieval. An automatic dial-out feature can be configured to obtain records from the Optimho relay.



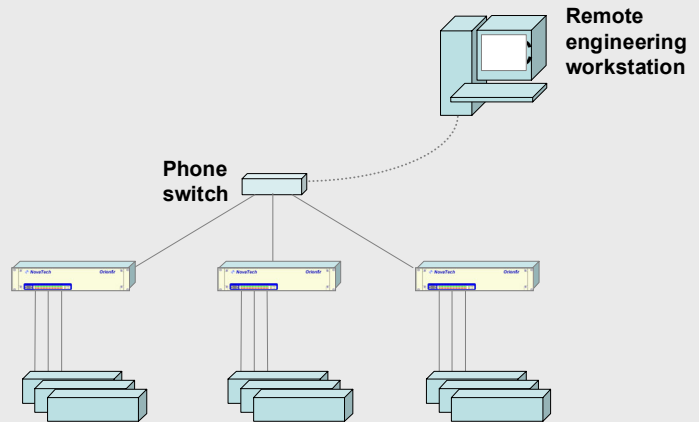
Orion is also designed to operate as a full-function RTU. See the RTU application page for details.

# Accessing Relay Engineering Data from Multiple Orions

Three options exist for establishing direct pass-through **phone connection** to relays attached to multiple Orions:

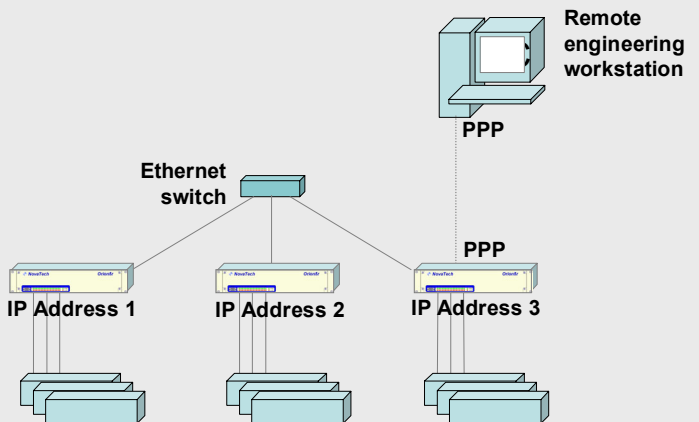
## Option #1

Connect the incoming phone line to a phone switch and distribute a phone line connection to each Orion. Select “pass-through” mode on Orion and connect to the desired relay.



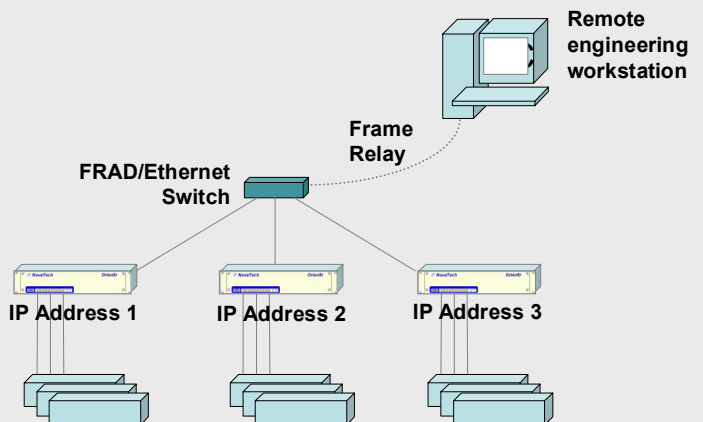
## Option #2

Configure the modem port on Orion for PPP and physically connect the two or more Orions on Ethernet. Dial-in, initiate a Telnet session, initiate PPP and select the IP address of the desired Orion. Select pass-through mode and connect to the desired relay.



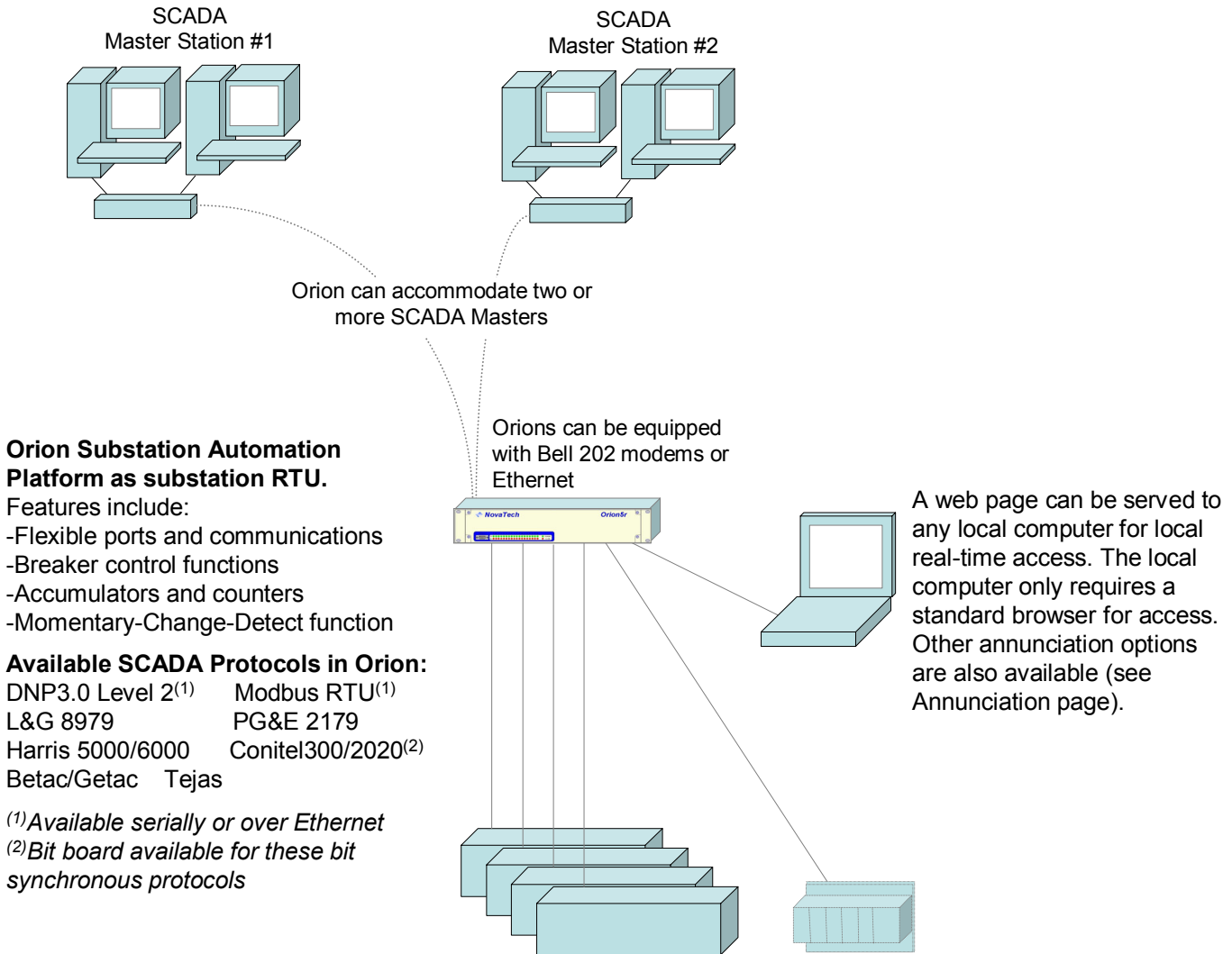
## Option #3

If Frame Relay is available, bring the line into an Ethernet-ready Frame Relay Access Device (“FRAD”). Connect the FRAD to the Ethernet switch (or use a combination FRAD/E-switch), connect the Orions on Ethernet, initiate a Telnet session and select the IP address of the desired Orion. Select pass-through mode and connect to the desired relay.



## Application #2:

# Orion Remote Terminal Unit Using Data from Your Protective Relays



### Protective Relays Connected to Orion

Orion is configured to communicate to each connected relay in any of the common utility protocols (DNP3.0, Modbus, Modbus Plus or Ethernet) or in the native relay protocol (e.g. SEL ASCII, ABB 10-byte, etc)

Orion is configured to poll the desired analog and digital points in each relay and to make these data available to the SCADA master. Configuration is through point-and-click selection of available points from pre-loaded relay "pick lists" in Orion.

**In applications where remote engineering access to the relays is also required**, two connections to each of the relays may be necessary to obtain acceptable RTU performance. The first connection may be used for access of the data required by SCADA and the second connection used to access data required by engineering (event records, oscillography, settings, etc.).

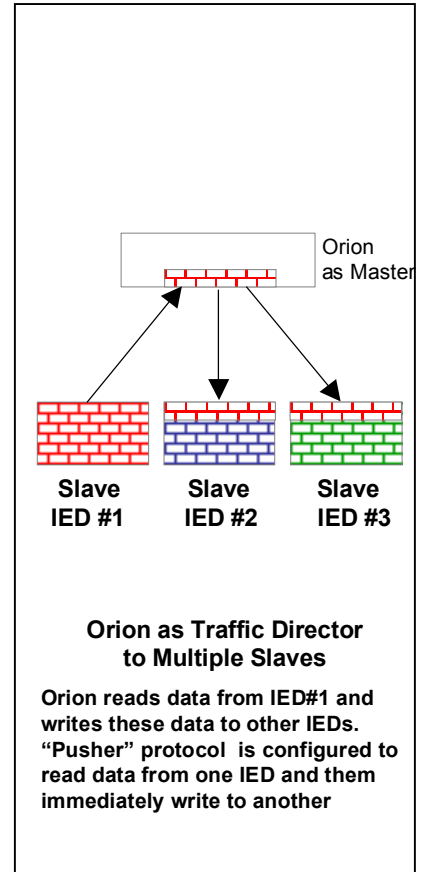
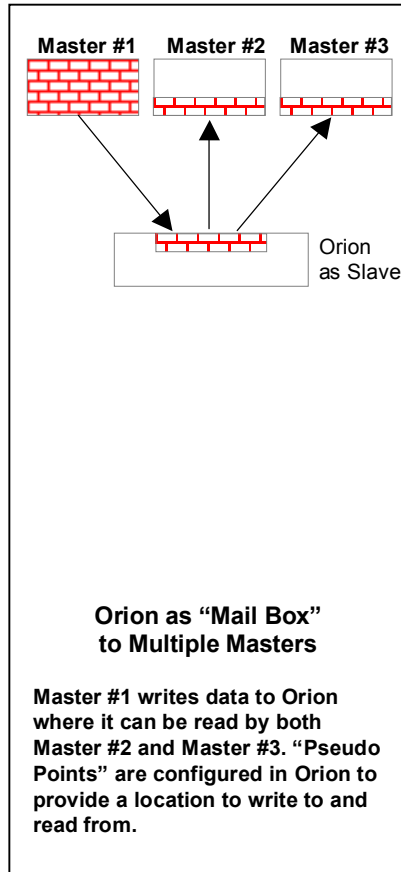
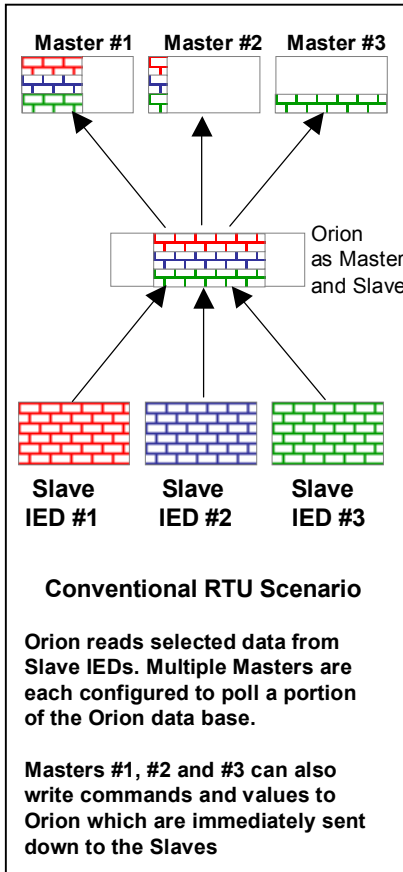
### Optional Internal or External Expansion I/O

, usually for inputs and outputs not connected to the relays, such as intrusion alarm, fire alarm, temperatures, indicator lights, etc, but can also be for trip/close or breaker status.

Depending on Utility practice, trip/close commands can be either routed to hard-wired expansion I/O outputs, or can be routed through the protective relay to the relay outputs.

Also, depending on Utility practice, breaker open/close status can be obtained from direct hard-wired expansion I/O inputs or obtained serially from the protective relays.

# Orion Master – Slave Scenarios for RTU Application and other Master – Slave Scenarios



All three of the above scenarios can be implemented in the same Orion at the same time

### Application #3:

## Automatic Substation Control with Orion Using Your Protective Relays as Virtual I/O

In traditional substation control systems, inputs and outputs are physically wired to control devices such as timers, counters, specialized controllers and protective relays. When these inputs, outputs and control elements are confined to one section or zone of the substation, as in breaker reclosing, this architecture is straightforward to implement. But when inputs and outputs are from multiple zones in the substation, as in many transfer applications, wiring can become complicated and expensive. The Orion Substation Automation Platform can reduce wiring and system complexity by obtaining control inputs from existing protective relays, and using protective relays outputs as control outputs. Control logic may reside in any of the following devices:

### 1) Control logic in Orion.

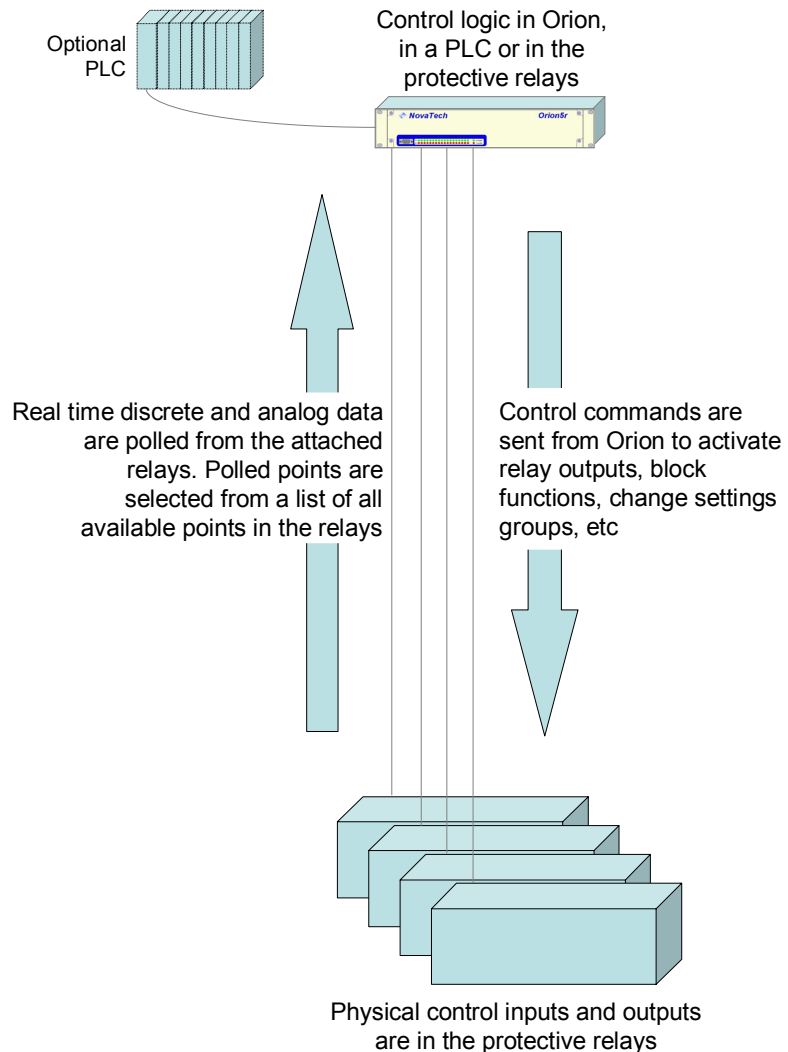
Orion can be provided with over 50 logic, control and math functions; attached relays become “virtual I/O” for this logic engine. Orion polls real-time inputs from the relays, processes logic and issues control commands to the relays.

### 2) Control logic in a PLC.

Orion can serve as the provider of “virtual I/O” for a PLC. Orion maintains a real-time database of discrete and analog data from the relays. PLCs can read this real-time data, process logic, and issue control commands through Orion to the relays.

### 3) Control logic in the relay.

Orion can route real-time data from one relay to another relay, and also route control commands from one relay to another relay.

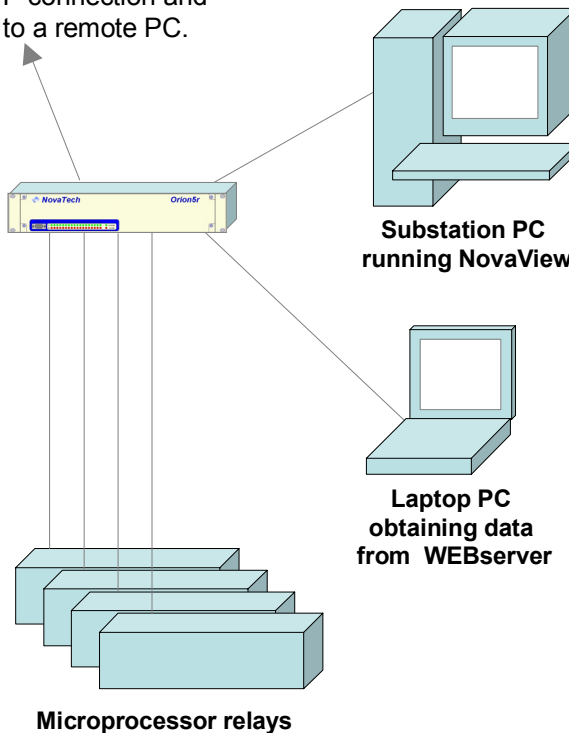


## Application #4

# Substation Alarm Processing and Annunciation with Orion Using Data from Your Protective Relays

Orion can be configured to notify remote operators of alarm conditions via a dial-out pager. Multiple numbers and retries can be configured

Orion can also be configured to dial out to an ISP, set up a PPP connection and serve out a web page to a remote PC.



Two NovaTech products can be used to locally annunciate alarm conditions:

NovaView Plus can provide complete substation visualization plus local record and event storage and trending. NovaView Plus can also be configured to remotely access real-time alarm conditions in the substation

WEBserver can serve out a web page from Orion to any local computer for local real-time access. The local computer only requires a standard browser for access.

Any of the real-time data residing in the attached protective relays can be accessed by Orion. Logic and math functions in Orion can be used to intelligently filter and condition these data to reduce false alarms and simplify analysis. For example:

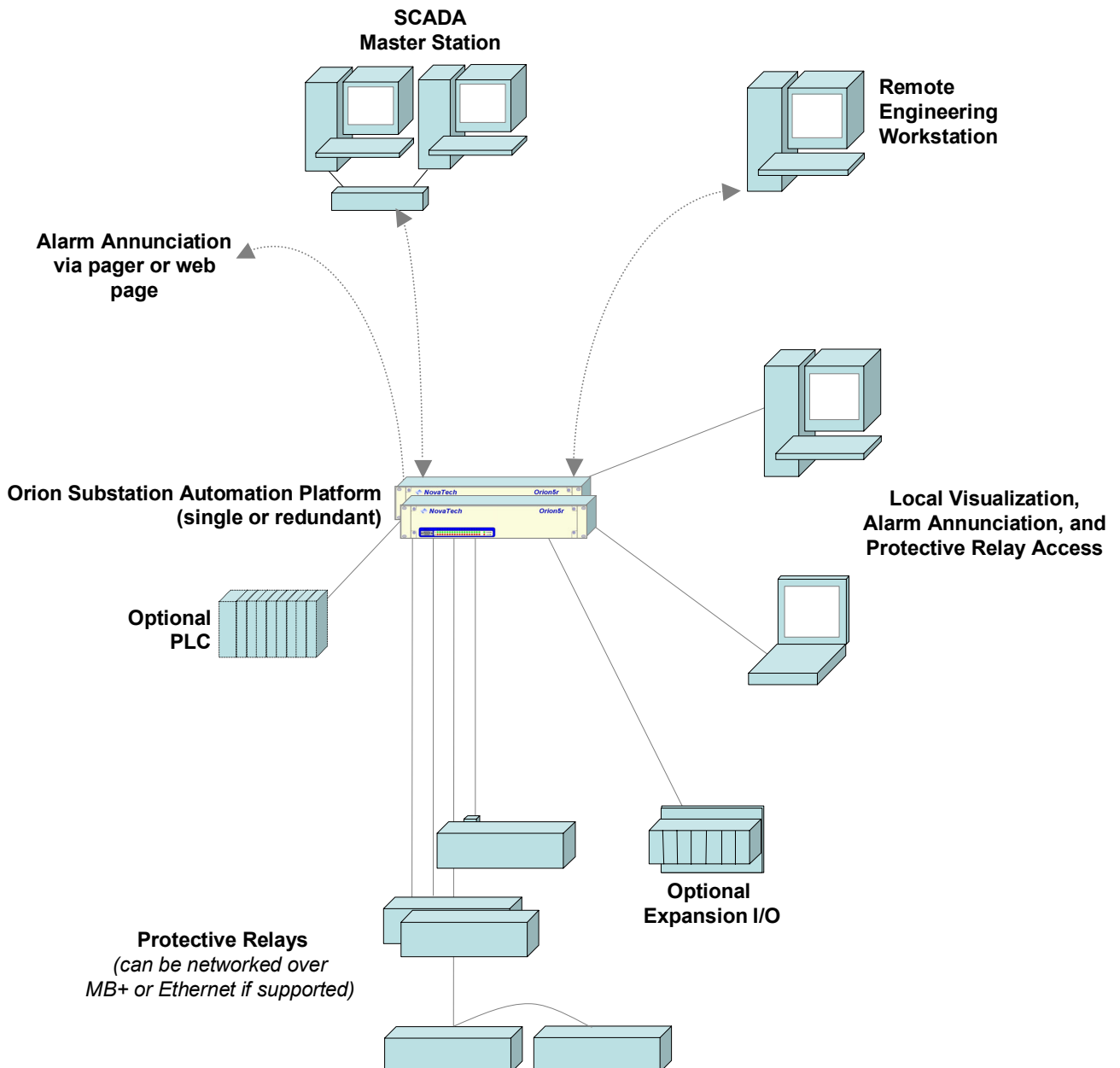
- Alarm "windows" with high and low thresholds can be set up in Orion, reducing the recording of multiple ON and OFF alarm states.
- Timers can be applied to certain alarms to ensure they are ON for a period of time prior to notification
- "AND" and "OR" functions can be applied to multiple alarms to make them conditional with respect to other alarms
- Intelligence can be applied to groups of alarms to reduce alarm load. For example, if all protective relays go into low power supply voltage at the same time, Orion could be configured to point the user to the substation battery or charger first.
- Alarms can be time-stamped in Orion to simplify analysis of higher-speed event trails

## Application #5

# Orion-Based Complete Substation Automation Using Your Protective Relays

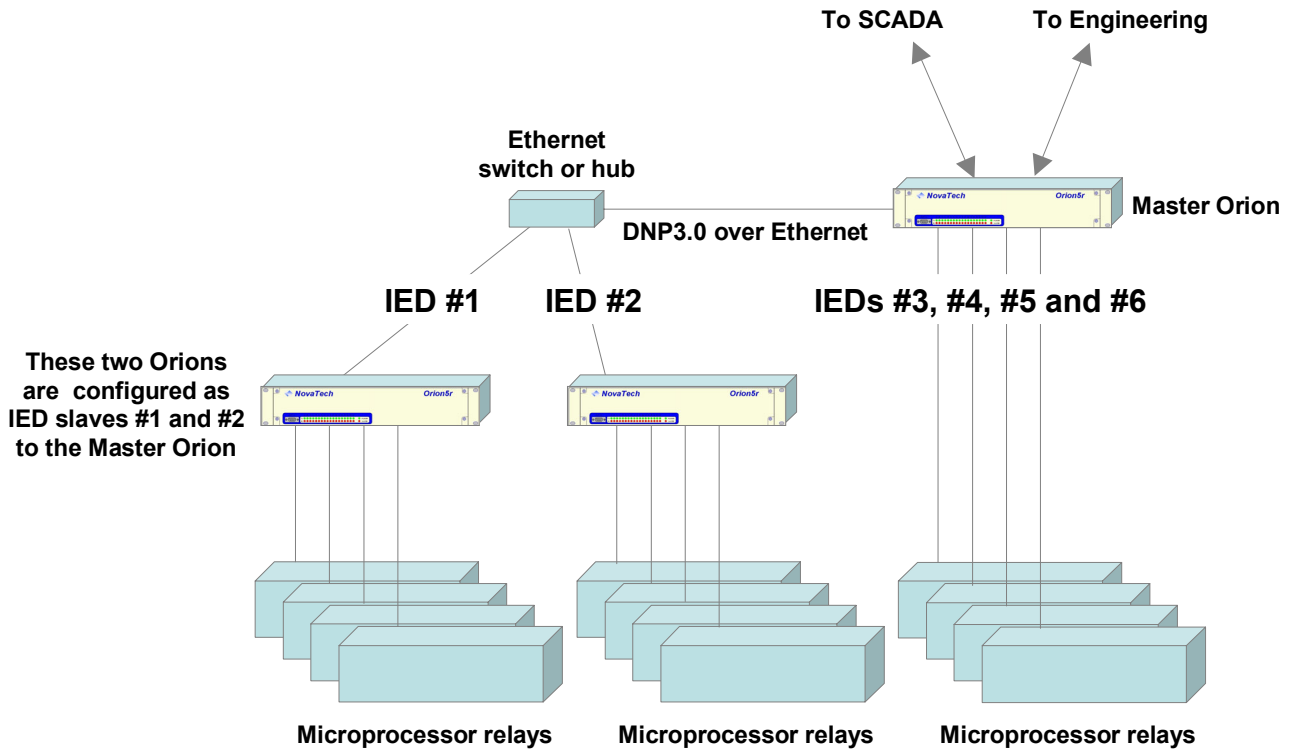
A complete Substation Automation system can be developed by combining all of the applications described on the previous pages. The functions of this complete system would include:

- 1) Provide local and remote engineering access to protective relay events records, oscillography and settings
- 2) Provide real-time discrete and analog data to the remote SCADA master (the RTU function)
- 3) Perform local automatic control functions in the substation
- 4) Provide local and remote annunciation of substation alarm conditions



# Large Automation Applications with Multiple Orions

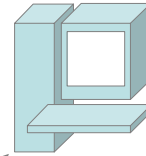
In applications where more than 19 protective relays need to be connected to Orion (and RS485 multidrop is not feasible), multiple slave Orions can be connected to a master Orion. Each slave Orion becomes another IED attached to the master Orion, just like any other slave IED attached to Orion. NovaTech recommends a fast communication medium and efficient protocol to maintain high performance in these larger architectures. Ethernet using DNP3.0 with report-by-exception will maintain acceptable performance in larger systems.



# Processing Sequence of Events Time Stamps with Orion

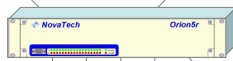
Accessing the time stamped data associated with events in protective relays and making these data available to the SCADA Master or substation HMI is a feature available in Orion. Orion uses its ability to independently poll relays, process data and respond to multiple masters (e.g. SCADA or HMIs) to make this possible.

To SCADA Master



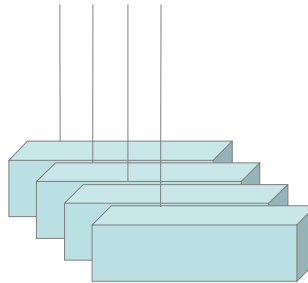
**NovaView  
Substation  
HMI**

2) Time stamps are sent out by Orion per the specific protocol. For DNP3.0, Orion responds to specific class or event polls with point status and formatted time stamp. Orion can also properly format time stamp data in Landis & Gyr 8979, Harris 6000, and other SCADA and HMI protocols.

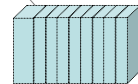


1) Time stamps are accessed by Orion per the specific protocol. DNP3.0 is commonly used for some relays; SEL FastSER for newer SEL relays.

Orion can also retrieve time-stamped data from Modicon PLC systems with Monaghan SER. The events and time stamps can be forwarded to the SCADA Master or the substation HMI

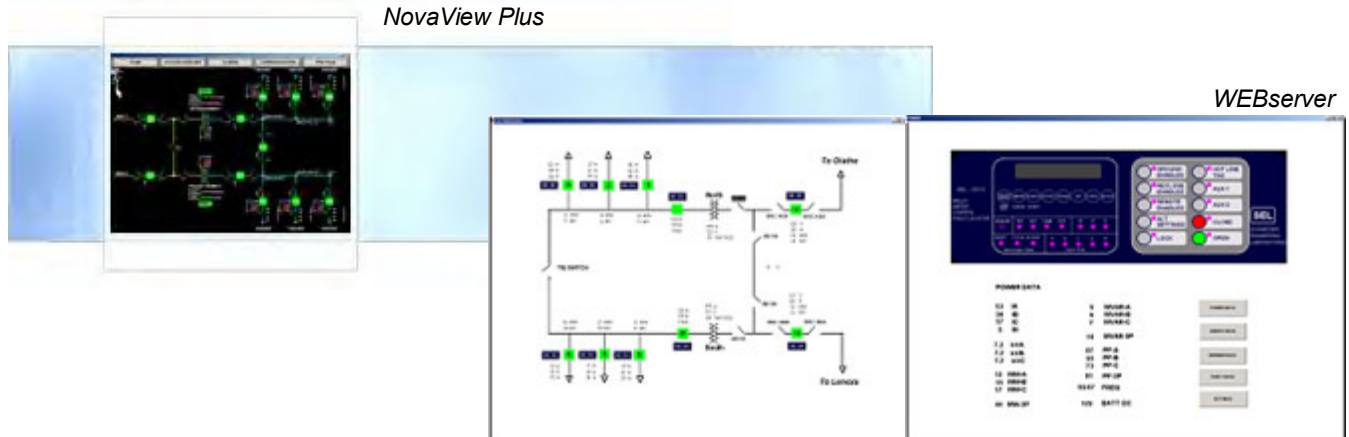


**Microprocessor relays  
supporting SER time stamping**



Note: See page 3 for a description of how SER time stamps applied to SEL relay events can be made available to devices attached to Orion.




# NovaView Plus and WEBserver Feature Summary



	<b>NovaView Plus</b>	<b>WEBserver</b>
<b>Graphical Capabilities</b>	<p>Full color and shape development. Linking to any real-time data in Orion database</p> <p>Existing SCADA screens or AutoCAD drawings can be used as a background</p>	<p>From simple text-based screens to detailed, full-color one-line diagrams. Linking to any real-time data in Orion database</p> <p>Existing SCADA screens or AutoCAD drawings can be used as a background</p>
<b>Required Hardware and Software</b>	CPU-Pentium-class 500mhz, 256 RAM, 40MB on hard drive, Windows 2000 or later	WEBserver runs on Orion Substation Automation Platforms. Internet Explorer™ is used to view pages served out by Orion
<b>Communication Protocols</b>	DNP3.0, Modbus, MB+, DNP3.0 over TCP, Modbus over TCP	Can be set up to communicate over a dial up PPP connection to an ISP or directly on broadband Ethernet
<b>Screen Development</b>	NovaTech graphical library and templates. Users can create their own templates as well.	Graphics package provided by NovaTech to create custom drawings
<b>Host Graphics Software</b>	Visual Basic 6.0	-
<b>Summary of Functions and Features</b>	<ul style="list-style-type: none"> <li>Data Acquisition; relays or meters</li> <li>LTC Raise/Lower</li> <li>Capacitor Bank Switching</li> <li>Sequence of Events</li> <li>Device &amp; Group Tagging</li> <li>Visual &amp; Audible Alarms</li> <li>System &amp; Station One-Line Diagrams</li> <li>On-line and Historical Trending</li> <li>Load Forecasting</li> <li>Outage Management</li> <li>Customized Reports</li> <li>Breaker Trip/Close; Select Before Operate</li> <li>Reclose Block; Ground Trip Block</li> <li>Auto Reclosing &amp; Sectionalizing</li> <li>Alarm/Event Reporting &amp; Logging</li> <li>Report by Exception</li> <li>Pseudo-Point Processing</li> <li>Multiple Drill-Down Levels</li> <li>Dial-up Remote Access</li> <li>IED Specific Displays</li> <li>Voice/Pager Activation</li> <li>Intelligent Alarm Management</li> <li>Redundancy: Automatic Throw-Over Without Data Loss</li> </ul>	<p>Supports multiple drill-down levels for displaying data; access to certain data can be restricted</p> <p>Allows load profile or event files to be uploaded from the Orion5, Orion16 or the IED</p> <p>Supports pass-through to the IEDs; all functions normally done over a dial-up interface are available</p>

# Orion Substation Automation Platform Family

## Feature Summary

	Orion5	Orion5r	Orion16
			
<b>Size</b>	6.4" wide x 5.5" high X 5.5" deep (6.7" deep extended)	2U, 19" rack mount, 13" deep	3U 19" rack mount, 14.5" deep
<b>Number of Serial Ports</b>	Up to nine	Up to 17	Up to 19
<b>Serial Port Configuration Options</b>	One port standard, plus up to two boards of four ports each optional. Various combinations of RS232, RS485 and fiber optic available (see data sheet)	One port standard. Each of 16 expansion ports individually provided as either RS232, RS485/422 or fiber optic	Three ports standard plus up to two boards of eight ports each optional. Various combinations of RS232, RS485 and fiber optic available (see data sheet)
<b>Protocol Flexibility on Serial Ports</b>	Each port can be configured for any of the available protocols <sup>1</sup> in master or slave	Each port can be configured for any of the available protocols <sup>1</sup> in master or slave	Each port can be configured for any of the available protocols <sup>1</sup> in master or slave
<b>Bit Synchronous protocols</b>	"Bit Board" with one port	"Bit Board" with one port	"Bit Board" with one port
<b>Ethernet Ports</b>	One	Two	One
<b>Modbus Plus</b>	N/A	One	One
<b>Profibus</b>	In development <sup>2</sup>	In development <sup>2</sup>	In development <sup>2</sup>
<b>Internal Dial In/Out modem</b>	Built-in dial-up, v.34 33.6Kbps	Built-in dial-up, v.34 33.6Kbps	Built-in dial-up, v.34 33.6Kbps
<b>IRIG-B</b>	N/A	Modulated or un-modulated input, un-modulated output	N/A
<b>SCADA Modem</b>	External Bell 202	External Bell 202	External Bell 202
<b>Physical Inputs/Outputs</b>	4in/2out std. Up to four local modules containing 8in/16 out or 16in/8out available	4in/4out std. Remote I/O Hubs available using 8in/16out or 16in/8out modules.	N/A
<b>Database – SCADA Points</b>	5000 typical	5000 typical	5000 typical
<b>Database – IED Points</b>	5000 typical	5000 typical	5000 typical
<b>Database – Points per Port</b>	2000 maximum	2000 maximum	2000 maximum
<b>Refresh Rate</b>	Less than two seconds	Less than two seconds	Less than two seconds
<b>Data Archiving Memory</b>	24MB	24MB	6MB
<b>Configuration Software</b>	NovaTech Communication Director (NCD)	NovaTech Communication Director (NCD)	NovaTech Communication Director (NCD)

<sup>1</sup>Available serial protocols:

DNP3.0 Level 2 Modbus RTU L&G 8979 PG&E 2179 Harris 5000/6000  
Conitel300/2020 Betac/Getac SEL Fast Meter Tejas

## NovaTech LLC: The Company

NovaTech LLC is a 150-person engineering, development and systems company with expertise in utility and process automation. NovaTech *Utility Solutions* provides products and systems to monitor and control electric substations. NovaTech *Process Solutions* provides products and systems to control discrete, batch and continuous operations in process plants.

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